International GLONASS Service – Pilot Project

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Abstract

The International GLONASS Service Pilot Project (IGLOS-PP) provided GLONASS observations and precise orbits from a tracking network of over 40 stations and three Analysis Centers for all of 2002. The International Laser Ranging Service (ILRS) also continued to observe three GLONASS satellites during the year. A new Russian launch of three satellites at the end of the year raised the number of available satellites to 10. After keeping the GLONASS data separate from the GPS data in the IGS for the first two years of the project, revisions were made to the IGS Site Logs, Analysis Center software and archival procedures at the Global Data Centers such that the IGLOS tracking data could be merged with the other IGS tracking data in routine operations. The accomplishment of this was a significant milestone.

GLONASS Constellation Status

On 25 December 2002, Russia launched three new GLONASS satellites into orbit plane 3 (slots 21, 22 and 23). This brought the total number of operational (healthy) satellites to 10. These satellites are the older series satellites (not GLONASS-M) and have SLR reflectors identical to the ones on the two operational satellites launched in December 2001 (132 corner cubes in panel). For most of 2002, there were 6-7 operational satellites.

Tracking Network

In coordination with the IGS GPS stations, all IGLOS stations were requested to submit new site log forms to become “official” IGS stations. These new site logs were designed to accommodate global navigation satellites in general, rather than just GPS, and to allow the full integration of dual GPS/GLONASS stations into the IGS. Only dual-frequency receivers capable of tracking at least four GLONASS satellites simultaneously were sanctioned as official IGS stations. As of December 2002, the IGLOS tracking network consisted of 46 stations, although six of these still lacked revised site logs. All the

operational stations use either Ashtech or Javad Positioning Systems receivers. The GLONASS data are now merged with the GPS data at the IGS Global Data Centers. Table 1 lists the IGLOS stations and their locations, receiver types, and sponsoring organizations.

The ILRS has provided continuous support for SLR tracking of three GLONASS satellites. In 2001, one GLONASS satellite in each of the three orbit planes was tracked (plane 1/slot 7, plane 2/slot 15, plane 3/slot 24). During 2002, the targeted satellites were changed to slots 3 and 6 of plane 1, along with slot 24 of plane 3.

Precise Orbit Computation

BKG and ESA produced precise orbits from the receiver network tracking data for all the operational GLONASS satellites. The Russian Mission Control Center (MCC) computes precise orbits based on the SLR observations alone. These individual orbits are combined in a weighted average computation by the IGLOS Analysis Center coordinator to produce the final IGLOS precise orbits. SLR orbit accuracies are probably at the 10-20 centimeter level, while the combined precise receiver-based orbit accuracies are about at the 20-centimeter level (see Figure 1). GLONASS orbit comparisons done at the Natural Environment Research Council (U.K.) have indicated that some long-term systematic biases may be present in the GLONASS receiver-based orbits compared to the SLR orbits.

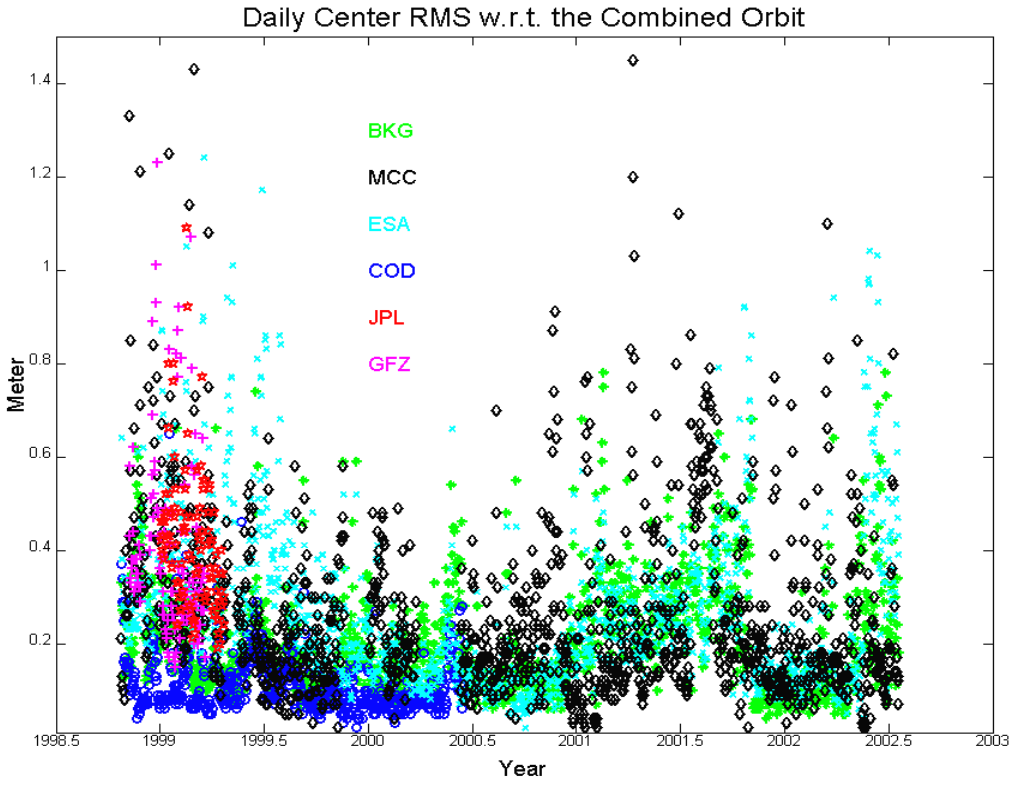

Figure 1

GLONASS Data and Product Usage

All receiver tracking data, including the satellite broadcast messages, and the precise orbit products are stored and retrievable at the IGS Global Data Center at NASA GSFC. Over an 11-month period from January to November 2002, 9,475 orbit products were downloaded from the Data Center. Two-thirds or more of these probably relate to the actual production of the precise orbits by the Analysis Centers in Austria, Germany and Russia, but at least 1,560 downloads are attributable to other users of the data products. These figures do not include downloads of the actual tracking data. It is not clear at this time what applications these products are being used for. This is definitely of interest and will be pursued in the coming year.

Summary

The number of active GLONASS satellites increased from 6 satellites in 2000 up to 10 satellites in March 2003. In the frame of IGLOS-PP precise GLONASS orbits are calculated by various Analysis Centers in regular (weekly) intervals. The accuracy of these orbits is about +/- 0.2 –0.3 m. Besides satellite clock offsets to GPS-time as well as station coordinates are provided.

Up to now the IGLOS products serve groups dealing with GNSS Time Transfer, all kinds of surveying using combined receivers (e.g. improving the situation in urban canyons with a lack of visible GPS satellites), and atmosphere monitoring for climate studies. A more rapid submissions of tracking data and a more frequent generation of products (compared to the current long latency) will certainly allow for a couple of new applications. Therefore the participants of the IGS Workshop in Ottawa 2002 passed a recommendations which asks all IGS-AC’s to intensify their ability to process data from combined GPS/GLONASS tracking sites.

There is an ongoing need to continue and to increase the tracking of GLONASS satellites by ILRS. GLONASS satellites observed by two independent space techniques realize a valuable kind of collocation in space. Moreover IGLOS-PP demonstrates the extensibility of IGS to accommodate other microwave systems (GLONASS, GALILEO).

Table 1. IGLOS Pilot Project - GLONASS Receiver Tracking Stations (Dec 02)

SITE NAME	SITE ID	LOCATION	COUNTRY	LAT. (deg)	LONG. (deg)	RECEIVER TYPE	CLOCK TYPE	SPONSORING ORGANIZATION
Crary	CRAR	McMurdo Station	Antarctica	-77.85	166.67	JPS Legacy	Internal	U.S. Geological Survey (USGS)
Davis	DAVR	Davis	Antarctica	-68.58	77.97	Ashtech Z18	Internal	Geoscience Australia
O'Higgins	OHIZ	O'Higgins	Antarctica	-63.32	-57.9	Ashtech Z18	Internal	Bundesamt fuer Kartographie und Geodaesie (BKG)
AU053	YARR	Dongara (Yaragadee)	Australia	-29.05	115.35	Ashtech Z18	Internal	Geoscience Australia
Brisbane	SUNM	Brisbane	Australia	-27.48	153.04	JPS Legacy		Dept. of Natural Resources, Queensland
Darwin AU014	DARR	Darwin	Australia	-12.84	131.13	JPS Legacy	Internal	Geoscience Australia
Mt. Stromlo	STR2?	Canberra	Australia	-35.32	149.01	JPS Legacy	Internal	Geoscience Australia
Mattersburg	MTBG	Mattersburg	Austria	47.73	16.40	JPS Legacy	Internal	University of Technology, Vienna
UNB, Fredericton	UNB1	Fredericton	Canada	45.57	-66.38	JPS Legacy	Internal	U. of New Brunswick
Concepcion-TIGO	CONZ	Concepcion	Chile	-36.84	-73.03	JPS Legacy	Internal	Bundesamt fuer Kartographie und Geodaesie (BKG)
Lhasa	LHAZ	Lhasa	China	29.66	91.10	Ashtech Z18	Internal	Bundesamt fuer Kartographie und Geodaesie (BKG)
Pecny (Ondrejov)	GOPE	Ondrejov	Czech Rep.	49.91	14.79	Ashtech Z18	Internal	Research Inst. of Geodesy, Topography & Cartography
Metsahovi	METZ	Kirkkonummi	Finland	60.22	24.40	JPS Eurocard	Ext. Quartz	Finnish Geodetic Institute
Dresden	DREJ	Dresden	Germany	51.01	13.43	JPS Legacy	Internal	Bundesamt fuer Kartographie und Geodaesie (BKG)
Frankfurt/Main	FFMJ	Frankfurt/Main	Germany	50.09	8.66	JPS Legacy	Internal	Bundesamt fuer Kartographie und Geodaesie (BKG)
Leipzig	LEIJ	Leipzig	Germany	51.35	12.37	JPS Legacy	Internal	Bundesamt fuer Kartographie und Geodaesie (BKG)
DLR IKN Neustrelitz	NTZ1	Neustrelitz	Germany	53.33	13.07	JPS Legacy	Rubidium	German Aerospace Centre (DLR)
Helgoland Island	HELJ	Helgoland Island	Germany	54.17	7.89	JPS Legacy	Internal	Bundesamt fuer Kartographie und Geodaesie (BKG)
Huegelheim	HUEG	Huegelheim	Germany	47.83	7.60	JPS Legacy	Internal	Bundesamt fuer Kartographie und Geodaesie (BKG)
Titz (Jackerath)	TITZ	Titz	Germany	51.04	6.43	JPS Legacy	Internal	Bundesamt fuer Kartographie und Geodaesie (BKG)
Wettzell	WTZJ	Koetzting	Germany	49.14	12.88	JPS Legacy	Internal	Bundesamt fuer Kartographie und Geodaesie (BKG)
Wettzell	WTZZ	Koetzting	Germany	49.13	12.87	Ashtech Z18	Internal	Bundesamt fuer Kartographie und Geodaesie (BKG)
Thule Airbase	THU2	Thule Airbase	Greenland	76.54	68.82	Ashtech Z18	Rubidium	Kort & Matrikelstyrelsen (KMS)
Reykjavik	REYZ	Reykjavik	Iceland	64.14	-21.96	Ashtech Z18	Internal	Bundesamt fuer Kartographie und Geodaesie (BKG)
Cagliari	CAGZ	Capoterra	Italy	39.14	8.97	JPS Eurocard	Cesium	Universita' di Calgliari
Ferrara	UNFE	Ferrara	Italy	44.83	11.59	Ashtech Z18	Internal	Agenzia Spatiale Italiana
Matera	MAT1	Matera	Italy	40.60	16.70	Ashtech Z18	H-maser	Telespazio S.p.A.
Mitaka A	MTKA	Tokyo	Japan	35.68	139.57	Ashtech Z18	Internal	Electronic Navigation Research Inst.
Delft	DLFT	Delft	Netherlands	51.99	4.39	JPS Legacy	Internal	Delft University of Technology
Gjovik	GJOV	Gjovik	Norway	60.79	10.68	Ashtech Z18		University College of Gjovik
Borowa Gora	BOGI	Borowa Gora	Poland	52.48	21.04	JPS Eurocard	Internal	Institute of Geodesy & Cartography
Wroclaw	WROC	Wroclaw	Poland	51.11	17.06	Ashtech Z18	Rubidium	Agricultural University of Wroclaw
Irkutsk	IRKJ	Irkutsk	Russia	52.22	104.25	JPS Legacy	H-maser	Inst. of Metrology for Time & Space (IMVP GP VNIIFTRI)
Khabarovsk	KHAJ	Khabarovsk	Russia	48.52	135.03	JPS Legacy	H-maser	Inst. of Metrology for Time & Space (IMVP GP VNIIFTRI)
Mendeleevo	MDVJ	Mendeleevo	Russia	56.03	37.50	JPS Legacy	H-maser	Inst. of Metrology for Time & Space (IMVP GP VNIIFTRI)
Novosibirsk	NOVJ	Novossibirsk	Russia	55.03	82.90	JPS Legacy	H-maser	Inst. of Metrology for Time & Space (IMVP GP VNIIFTRI)

Table 1 (cont'd). IGLOS Pilot Project - GLONASS Receiver Tracking Stations (Dec 02)

SITE NAME	SITE ID	LOCATION	COUNTRY	LAT. (deg)	LONG. (deg)	RECEIVER TYPE	CLOCK TYPE	SPONSORING ORGANIZATION
SP Boras	SPT0	Boras	Sweden	57.71	12.89	JPS Legacy	Cesium	National Land Survey
Kiruna	KR0G	Kiruna	Sweden	67.88	21.06	Ashtech Z18	Internal	National Land Survey
Maartsbo	MR6G	Maartsbo	Sweden	60.60	17.26	JPS Legacy	Internal	National Land Survey
Onsala	OS0G	Onsala	Sweden	57.40	11.93	JPS Legacy	H-maser	Onsala Space Observatory, Chalmers
Visby	VS0G	Visby	Sweden	57.65	18.37	Ashtech Z18	Internal	National Land Survey
Zimmerwald GPS97	ZIMZ	Zimmerwald	Switzerland	46.88	7.47	Ashtech Z18	Internal	Swiss Fed. Office of Topography
Zimmerwald GPS87E	ZIMJ	Zimmerwald	Switzerland	46.88	7.47	JPS Legacy	Internal	University of Berne (CODE)
Herstmonceux	HERP	Hailsham	United Kingdom	50.87	0.34	Ashtech Z18	GPS/DFS	NERC Space Geodesy Facility
Greenbelt	GODZ	Greenbelt	United States	39.02	-76.83	Ashtech Z18	H-maser	NASA Goddard Space Flight Center
Woodinville	DWH1	Woodinville	United States	47.77	-122.08	JPS Legacy	Cesium	Hogarth, Douglas